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PEACETIME VALUES FROM A WAR TECHNOLOGY[1]

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INTRODUCTION

IN a world at war one gets the impression that all forces are solely for destruction. When war ends, the new technology will more quickly, efficiently and effectively convert the war effort to the pursuits of peace with an amazing speed. With the tremendous increase in research and development, the commercialization of processes has occurred which would have taken years under normal conditions to reach fruition. Out of the welter of the war effort, values will flow that will increase man's effective span of life with greater satisfaction for living.

Science has already prolonged and saved man's life through germ-killing chemicals, new anesthetics and synthetic vitamins. Through scientific and technical research our food supply has increased in quantity and quality. Synthetic textiles have provided us with more beautiful, durable and sanitary clothing. Plastics will revolutionize the building arts, for the trend is to supplant many house-building and house-furnishing materials with plastics as soon as they can be released for civilian use. Plastics together with new and more efficient fuels will also play a dominant part in our transportation systems.

Let us look at the transportation situation first. The petroleum industry will play a controlling part in this. Airplanes hurtling through the air at over five hundred miles an hour carrying a thousand or more passengers will make all parts of the world less than twenty-four

[1] Presented at the Wartime Marketing Conference, American Management Association, Drake Hotel, Chicago, January 14, 1943.

hours away from Chicago. Luxurious as the *Normandie* and *Queen Mary* were for ocean travel, airships yet to come will operate with a smoothness and comfort unknown to-day. Low cost air travel and jitney planes should be within the pocketbook of every American. The competitive impact of the new airplane industry on all other forms of transportation may be quite serious.

Increase in air travel will be made possible primarily by the capacity of the oil industry, increased by wartime demands to produce 100 and higher octane gasoline, and by the amazing developments in airplane design, material and construction that have been forced by the hard hand of war necessity.

The same technique and the same processes that produce 100-octane gasoline in almost unlimited quantities for airplane use will also mean greatly improved fuel for automobiles; in fact, at least 50 per cent. more miles per gallon. We may hazard a guess that the automobiles to come after the war will give new pleasure to driving because of their improved design, speed, safety and beauty.

In the short span of twenty-five years, man has entirely revolutionized transportation through the design and construction of the automobile and airplane and petroleum products. By careful study and experimentation, it is certain we can produce from petroleum better rubber than was ever obtained from trees or plants, and tires which will give 100,000 miles or more of trouble-free service are a reasonable expectation of the future.

For years we have been led to believe that world leadership in research and development rested squarely on Germany and that the United States was laggard. Even now statements are made from time to time to the effect that we are still behind Germany in research, development and commercialization. This is not so to-day with the facts. There was an element of truth in such a statement during World War I when the United States was short of many necessary materials due to its reliance on Germany for pharmaceuticals, dyes, fine chemicals, potash, lenses, chemical glassware, instruments, etc. We are now completely independent of any country for these and other materials.

Prior to the previous war it was thought that if one wanted to study chemistry, physics, mathematics or medicine, one had to go to Germany, but that day is also gone forever. In less than twenty-five years the United States has reached world leadership in research and has awakened to a miracle of scientific and technological development under our system of free enterprise.

Private initiative is responsible for America's world leadership in science and industry. The tremendous effort that is being put forth in the United States, the effort that will win the war, is the work of private initiative.

The impact of researches, carried on by private corporations and speeded up enormously by the war, will bring vast changes in our peacetime economy. Their research departments were the organizations upon which many companies relied to bring them out of the depression. Their results are the backbone of the country's mobilization for total war.

Obviously, in the time allotted this evening one can but show a few highlights in the accomplishments of research.

The fact that many of nature's products have been unsatisfactory has stimulated man's inventive faculty fortified by the vision prevailing in our industries. The tremendous cooperation of industry in the United States is responsible for the spending of millions of dollars to develop a basic idea for the welfare of mankind. No industry stands alone in achievement, as they are all interrelated through research.

The destructive nations' efforts to rule the world must be wiped out as surely as we must defeat the insect and bacterial hordes that prey upon us.

HEALTH ENGINEERING

Man's struggle to survive is ever present. He has either vanquished or domesticated large animal life. Our present battle is to overcome the ravages of rats, insect life and bacteria; it would seem that the smaller the scale of life the more difficult is the problem of its extermination or control. Even the very nature of some of the smallest forms has presented man with some of his greatest difficulties of discovery and eradication by chemical or physical means. Great strides in this direction have been made, but the ultimate solution is still far off. Increased tempo in research and experimentation along many fronts will ultimately present the remedy, but with the vastly improved tools man is constantly providing for himself, the end is certain to be on the favorable side for mankind.

From the necessities that war has forced upon man have grown the scientific principles of health engineering so vitally necessary to man's well-being as a fighting force. Accurate knowledge of vast areas hitherto seldom visited by dwellers in temperate regions have been the motive force behind a medical exploration of tropical territories that may well be carried over in the future development of our own hemisphere.

When it became necessary to provide troops with anaphylactic measures against tropical and sub-tropical diseases, it was the problem of the medical force to provide accurate knowledge of the type of health dangers encountered and to provide prevention and

cure of malaria, cholera, typhus, hookworm, bubonic plague, sleeping sickness, dysentery and typhoid. Mosquitoes, rats, leeches, fleas, flukes, bats and a host of other disease-bearing or spreading agents had to be studied and their control and extermination planned. Drugs of all types had to be ready for disease combat and the checking of infection.

In the Far Eastern and African campaigns insects and infections have beset our armies. Our men went down with malaria and other diseases. Among these are dengue fever, dysentery, tropical ulcers and sores, as well as the bites of malarial mosquitoes and tropical spiders, some as large as crabs. There is a drainage of the soldier's vigor in this pestilential atmosphere wherein he fights, eats and sleeps but a few hundred miles from the Equator. As one eyewitness expressed it about the Buna campaign:

> . . . that every ounce seems to grow to 10 pounds when carried through a jungle through knee-deep mud. That means giving soldiers jungle equipment, including the lightest kinds of carbines, tropical uniforms, waterproof shoes, more efficient and lighter packs, as well as smaller mosquito nets.

What has research done to modify this type of torture and death to which our fighting forces are subjected? The methods of attack are chemical, physical, medical and engineering.

An indispensable tool in the study of man's health for many years has been the microscope, discovered over three hundred years ago. Slow improvements had been made in this instrument until a few years ago when a revolutionary principle was discovered through the use of the electron. This made possible a magnification of over 200,000 times compared to the 3,000 from the best previous microscope.

Anti-insect sprays, delousing, swamp drainage, felling of certain trees, sanitation, oil and chemical dust spreading and other methods are used to keep our troops in fighting condition and will have great value industrially and agriculturally during peace.

A number of synthetic chemicals, such as the sulfa drugs, synthetic quinine and synthetic vitamins are finding amazing uses on the fighting fronts. Where the World War I record was four deaths out of five due to germ infection of abdominal wounds, the present record is one out of five. Quoting Howard Blakeslee:[2]

> On the 2,000-mile front, in all the war, only 1.5 per cent. of the Russian wounded have died. That is slightly higher than the remarkable recovery rate at Pearl Harbor, 96 out of each 100. The report says the Russian recovery rate is 98.5 per cent. of all wounded. The Russian rate is one-half of 1 per cent. worse than the Guadalcanal miracle of 1 per cent. of wounded dying. . . .
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> The Russians claim some new medical advances of their own. When plasma is made in America, the red blood cells are thrown away. The Russians report that they have made a process to use these cells to manufacture blood. Nerve sections taken from the dead have been successfully grafted into the wounded. The peritonea of animals, the inner linings of visceral cavities, have been used as living bandages for gaping wounds. It is claimed that cure is facilitated and that the scars are not so heavy. . . .
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> A compound that is not a vitamin, yet has the blood-clotting effects of Vitamin K, is in use. The Russians say they have found a method to obtain thrombin in thousands of quarts volume. Thrombin is a natural clotting substance in blood.

[2] *New York Times*, January 10, 1943.

The latest sulfa drugs which are working wonders against infection and disease are sulfathiazole, sulfapyridine, sulfaguanidine and succinyl sulfathiazole which have been synthesized for specific diseases. Each soldier's kit contains first aid doses of sulfanilamide for the purpose of checking infection at the time a wound is received.

Pentothal, which is injected intravenously, is one of the very best of the newer anesthetics, having no explosive hazards such as ether and the hydrocarbon gases. In addition, the equipment necessary for its administration is simple. A shot in the arm is all it takes to put one asleep.

Bacteria, soil molds and molds found in the intestines of animals or insects create chemicals that are highly useful in destroying infection. Penicillin, a new drug produced in soil mold, is about 100 times as effective as sulfanilamide for combating infection and far less toxic. Gramacidin from soil bacteria has been found to be a powerful germicide for both pneumococci and streptococci, two extremely dangerous germs to man.

One can not pass public health without mention of the vitamins. Many diseases of baffling nature have been due to dietary deficiencies and upon treatment with the proper vitamins have been cured. New methods of production, mainly chemical synthesis, have made vitamins available. Vitamin C (ascorbic acid) and Vitamin B_1 (thiamin chloride) are probably the most outstanding examples. In 1933 the cost of Vitamin C was $213. per ounce; in June, 1942, the price had been reduced to $1.65 per ounce. Vitamin B_1 was sold for $8,000 per ounce in 1935 and is now marketed at $15.00 per ounce. Because of the huge reductions in price, these vitamins as well as several others can be added to fortify various foods, giving them protective factors for health never before included in their manufacture.

FOOD

Food plays the dominating role in all nations. Rationing has hit all of us, hence our keener interest in this subject. Research has made available foods relatively new to our civilization, not alone from the standpoint of new varieties but chemicals used for

treatment increasing their quality, size and vitamin content.

Petroleum plays a role in the newer methods of increasing food supply. When oil is cracked to produce motor fuel, olefinic gases are by-products. These gases, such as ethylene, propylene and butylenes, hasten fruit ripening and growth. Ethylene was first used for the purpose of ripening oranges rapidly, by putting a tent over each tree or storing the unripe fruit in a room and adding small percentages of ethylene. By using this method of ripening, the fruit could be shipped without loss due to rotting. The growth of potatoes has been stimulated by ethylene and propylene. It has been reported that the speed of growth of potatoes has been increased 100 per cent. when the seedlings have been treated with ethylene. The growth time to maturity was shortened, while at the same time the potatoes were more numerous and larger and contained higher percentages of Vitamin C.

The Russians have studied the use of butylene gas, showing that it has a stimulating effect on the speed of growth of trees, such as the apple, apricot, pear, cherry, plum, peach and walnut, bringing them to fruition far faster than without its use. Where the growth season is too short to allow the full maturing of trees due to the inclement weather in parts of Russia, so that flower formation and fruit setting are delayed, butylene has been used to hasten the growth period. The method of treating a tree is to enclose it in a tent for two weeks before the normal or desired leafing, *i.e.,* start of the growth cycle. Butylene is passed into the tent in concentrations of one part in a hundred thousand parts of air at temperatures between 69 and 100° F. for a period of one to two hours. Small heaters are probably used to raise and maintain the temperature of the air around the tree so as to obtain maximum effects of the growth-inducing hydrocarbon, butylene.

Acetylene, so important in the production of synthetic rubber, plastics and other materials, is being used in Australia to increase the growth of pineapple plants. Calcium carbide, derived from coal and limestone, is placed in the heart of the plant, and rain or dew reacts with it to produce acetylene in sufficient quantities to increase the growth of the pineapples.

In California, fruit orchards are fertilized by ammonia added to the irrigation water, which has markedly improved productivity. It may be of interest to point out that this ammonia is produced from the nitrogen in the air and the hydrogen from cracking of petroleum.

The autumn crocus contains a yellow powder called colchicine, which is extracted from the plant. This powder when applied to seeds, leaves or buds of a plant increases growth of fruits and vegetables to double their normal size. Colchicine also gives rise to new varieties of fruits and vegetables never known before. The colchicine acts at a very critical point in the germination of the seeds. When cell division is ready to take place, the cell does not divide, which is usual in nature, and the specie-bearing chromosomes remain in the seed in double the number, giving rise to new species of fruits and vegetables.

Shipping of food supplies to the United States fighting men abroad is in a critical situation because of lack of transportation. To overcome this obstacle a number of processes have been developed to dehydrate foods in order to cut down their bulk and weight.

"Quick freezing" of fruits, vegetables and meat has added materially to food supply, particularly in decentralized communities, and also conserves steel and tin in the form of cans. This development has great economic value for peace and war.

The impact of these researches on the food economy of the world will develop enormously in that one may work out new hormones and chemical stimulators which will give rise to new plant life.

Developments already achieved present an almost incredible picture of our food supplies of the future. Obviously these developments will make it possible to raise more food of higher nutritive quality on less acreage, with far less labor compared to present methods.

Textiles and Clothing

For years the silkworm was the sole producer of the raw material used in weaving fine silk fabrics symbolic of richness and luxury. Marco Polo in the fourteenth century introduced these fabrics into Europe. The products from the silkworm held leadership for centuries as a symbol of wealth. The silkworm's job is well-nigh finished, although silk will probably find a number of special uses. The research chemists have developed synthetic silks far superior to the best that the silkworm can do. Rayon is one of the earliest of the silk substitutes and was produced primarily from wood and cotton linters.

The most striking development in the textile and plastics industries in the past few years is the commercial production of Nylon. One of the main uses of Nylon was for hosiery that has at least ten times the wear quality of the best silk from the worm. Nylon is now used largely in parachutes and for ammunition bags, in which it replaces natural silk.

Structural Materials

After World War I a great impetus was given to the building arts. Structural steels, alloys, aluminum, concrete, synthetic stones, plywoods, insulators, plastics and a host of other materials were generally made

available. A new era in design, building, housing and transportation will be the aftermath of the present war with the many new materials now produced which will be diverted from the war to peace. A tremendous business potential is ahead of all of us, which will strain us to the limit to fulfill the demands of building, furnishings, automobiles, trains, etc.

Glass

For thousands of years almost no progress was made in the glass industries of the world. The only researches of moment were through the addition of minerals to give beautiful colors to the windows of the world's cathedrals. Researches in the glass industry of the United States since World War I have made amazing strides in the materials that can be produced from sand. In World War I this country was cut off from the chemical glassware and lenses of Germany, which held leadership at that time. We are now entirely independent of any foreign country, for we have developed new products from sand that are leaving their impact upon other industries in a competitive way that will be intensified in the peace period to come. Mass production of hard glass for laboratory use has found its way into everyday life in its use for baking and other heat-resisting utensils. In addition to this development, the present war is bringing out the utility of glass in jobs which were previously taken care of by steel, silk and cork. Glass fiber boards for heat insulation in fighting planes have saved five and one-half million pounds of aluminum and other scarce lightweight metals which can be used in building 250 Flying Fortresses. For electrical insulation, glass filaments are spun which make a flameproof wire coating for use in heavy bombers. Glass foam has found use in displacing cork in life preservers and life boats. Unlike air-filled rubber floats, a puncture is not vitally destructive, since, when a bullet passes through, only the cells in the immediate vicinity are destroyed. One of the outstanding uses of spun glass in the present war is as a replacement for silk and gut in surgical sutures. Spun glass is also widely used as a fireproof textile. Some of the newer optical glasses use no sand at all, but depend upon the rare earth elements such as tantalum, tungsten and lanthanum. The glass made from these materials is highly satisfactory for use in aerial photography lenses, since it gives more sharply defined images at higher altitudes than ever before possible.

Plastics

The plastics industry was founded years ago by Hyatt, an American. He was the first to work with cellulose nitrates and camphor as a plastic mass in an effort to find a substitute for the ivory in billiard balls. In general, however, the founding of the modern plastics industry occurred in 1907 when Dr. Leo H. Baekeland produced in his laboratory in Yonkers, N. Y., the first phenol-formaldehyde products, commercially known as Bakelite. This American research was the stimulating force that has brought the plastics industry to the important position it now holds in our war effort. World leadership in the plastics field is without question in the United States. One can be clothed from head to toe by plastics that are now available. One may live in a plastic house and be transported in vehicles largely made of these materials. There is no end to the variety of plastics that are potentially available and in the making.

These remarkable plastics have at least 100,000 uses. Perhaps one of the most important at the moment is for the production of hoods for pilots and gun turrets on airplanes, where prolonged high visibility is so essential. One of the most important plastics is Plexiglass, made of methylmethacrylate. The flexibility of this material lends itself to forming any shape desired by molding. In addition to clarity of vision, which these plastic windows give for a long time, they are practically shatter-proof.

It is to be expected that in the automobile to come plastics will play a great part in its structure. One may expect practically 100 per cent. visibility in the new type car based on plastics. For these uses it will be highly competitive with other types of structural materials.

Much has been accomplished in the United States in brightening life, housing and transportation by the use of plastics of every color. One may say that the period in which we are living is the renaissance of color. This reawakening to color values was apparent before the global blackout. Many plastic products form excellent media in which the commercial artists and designers have expressed their art in home and business interiors. Current United States magazines are full of beautiful illustrations of radios, electric irons, telephones, airplanes, milady's boudoir, many of which are made of plastics.

The color effect of these plastics plays a definite role in the well-being of humanity and in our capacity for work. This industry of color effect from glasses and plastics has not been fully exploited. However, a number of manufacturing plants have worked out color schemes that raise the tempo of production and ease fatigue at the same time. Eyestrain particularly is in general an overlooked factor in well-being and productivity. Walls of dull gray, brilliant white and black machines in many cases contribute to accidents. The fatigue factor also holds for office work and study should be given to the relation of color to accuracy and output of those engaged primarily in mental activity.

In general, the architect in planning buildings has limited himself as regards color to a comparatively narrow range, gray portland cement, red sandstone and gray, red, and yellow bricks, etc. Newer building plastics are available in colors as beautiful and far more practical than precious stones whose colors they imitate. The architect could well use plastics in slabs that would give us colorful buildings at low cost.

One may expect that the new plastics will play a competitive role with building and window glasses. Both the plastic and glass industries will also be highly competitive with the paint and varnish industries.

SYNTHETIC RUBBER

We were caught with our natural rubber supplies shut off by the devastating attacks of the Japanese, who now control over 95 per cent. of the world's rubber supplies. In normal times the United States requires about 600,000 tons for its peacetime pursuits. Fortunately science and research in the United States were not caught napping in the knowledge and technique for the production of synthetic rubber. For a matter of twenty years or so, long before the fall of the Far East, processes were available to produce synthetic rubber. The production schedule is for 1,100,000 tons of synthetic rubber for the war effort. The synthetic rubbers, Neoprene, Thiokol and Ameripol, were in commercial production prior to the fall of the East Indies. The "know how" of producing other rubbers, such as Buna-S and the butyl type rubbers, was also available. The United States has all the raw material necessary to produce any quantity. It is now a question of materials and their fabrication to equipment in order to construct the plants already O.K.'d by the government.

Neoprene rubber is based upon acetylene—the same acetylene that induces plant growth and is the basis of a whole host of other products.

Acetylene is one of the most important of all the hydrocarbons, and has been produced through the years almost entirely from coal and limestone in electrical furnaces. One of its primary uses for years has been in acetylene welding and now in synthetic rubber. Researches have been going on for years in an endeavor to use our vast natural gas and petroleum resources for the production of acetylene. There are a number of commercial units now under construction, one of which will produce at the rate of 75 tons a day of acetylene, or 27,000 tons a year. It is believed that acetylene will be produced at a lower cost from processing our natural hydrocarbons than by the high temperature electric furnace method. The natural gas industry of the United States produced in 1942 about 3,000,000,000,000 cubic feet of gaseous hydrocarbons, part of which could supply the whole world with acetylene and its derivatives.

Thiokol is manufactured from ethylene derived from the cracking of oil, chlorine and sulfur, whereas the Buna-S rubber is produced from styrene from coal and petroleum, and butadiene derived from grain alcohol and petroleum.

Butyl rubber is based upon the chemical reaction of isobutylene, butadiene or isoprene.

We are being geared to produce synthetic rubbers in the following tonnages:

	Tons per year
Buna-S	845,000
Butyl	132,000
Neoprene	69,000
Thiokol	60,000

The world's natural rubber production for 1941 was 1,675,000 long tons, of which the United States imported 820,000 tons. With the tremendous number of airplanes, tanks, motor trucks, ships, trains, gun mountings, etc., the rubber demands are ever increasing, not alone for the fighting forces on the far-flung fronts, but for the necessary war work behind the lines. A statement appeared a few days ago that ground tanks were passé due to the fact that the heavy guns of the United States were able to smash them. If this be so, then airplane tanks heavily armored for low altitude flying should be the answer, and this will call for increased quantities of rubber. Medium size tanks require 500 pounds of rubber and pontoon bridges over 1,000 pounds. The gasoline tank alone of a Flying Fortress uses 500 pounds of bullet-sealing rubber, while large bombers require over 1,200 pounds. Gas masks use three fourths of a pound, while battleships use between 75,000 and 150,000 pounds. Excavation trucks used by the Army with tire diameters of nine and one half feet require about 3,500 pounds. There are many hundred more products requiring rubber that are vital in the war effort, such as blimps and barrage balloons. The latter have not been used in the United States to any extent. However, if the war reaches our shores tremendous quantities of rubber will be needed for this purpose. Rubber boats, rafts, safety vests and suits for flyers, hospital rubber requirements, etc., are also some of the products demanded from the rubber industry.

Ironically, press dispatches from the Far East indicate that the Japanese are cracking rubber to produce gasoline and other oils, which is an indication that they have a shortage of oil despite the fact that they have taken over the Far Eastern oil fields of the Netherlands and the British. As a contrast, in the United States we crack petroleum to produce synthetic rubber and gasoline.

You may well ask the question: Is synthetic rubber equal to the natural? One may say, the synthetic product is at least equivalent to the natural, but as of to-day it does not duplicate it, nor is it essential to duplicate nature's product, for the chemist's goal is

to produce rubber with far superior properties to the natural. It has already shown far superior properties from the standpoint of gasoline, oil and chemical resistance. The synthetic product has greater wearing properties, and does not deteriorate readily in sunlight and air.

A number of trucks and motor cars using synthetic rubber have gone over 35,000 miles, and one may reasonably expect at least 100,000 miles with the amount of research going on in the laboratories of the United States. The greater general strength of a synthetic tire means less driving hazards and far better road gripping. The latter property has been thoroughly tested on wet and muddy roads. Hill tests made with a number of trucks on a muddy road showed that the synthetic-tired vehicle had very little side-slipping, while the natural-tired vehicle slipped all over the road. Taxicab drivers advise that they all feel far safer in driving in mud or on wet city streets when their cabs are tired with synthetic rubber.

The research laboratories of the United States have discovered at least three thousand synthetic rubbers of varying properties. Some of them are exceedingly expensive to produce and others relatively low priced. One may state that synthetic rubber for tires will be highly competitive with the natural rubber, and in mass production synthetic should be less than 15 cents a pound. Natural rubber has sold through the years at prices varying from 3 cents to $3.00 per pound.

We are in a rubber crisis which may mean that all motor vehicles not used in the war effort will cease operating in order to be sure that all our fighting fronts will have sufficient rubber for ultimate victory.

Synthetic rubber must be provided at the rate of at least 1,100,000 tons a year called for by the Baruch Committee. Never again should the United States be caught short of rubber, whether in war or peacetime.

Aviation Developments

Scientific, technical and industrial miracles are taking place throughout the United States, not the least of which is in the airplane industry. In a few years production of airplanes has stepped up from less than 1,000 per year to over 48,000 in 1942, with 100,000 projected for 1943. It is not solely a question of the number of planes but their design, quality and size based on incorporating the knowledge gained on the fighting and research fronts.

Extraordinary strides have been made in the fabrication of airplane engines, propellers and bodies. The materials of construction are now of aluminum, magnesium and their alloys, stainless steel, plywood and plastics. These will be highly competitive after the war. Aluminum alloy forgings for cylinder heads stepped up the horsepower of the engines 15 per cent. as well as decreasing its weight. Seversky reported that a 32,000 horsepowered airplane was in the making, using four 8,000 horsepower engines. A Flying Fortress, the U. S. Army B–19, is an 8,800 horsepower airplane, with a 36,000 pound high explosive carrying capacity. In contrast, "Air Jeeps" of 65 to 100 horsepower are in our fighting forces on the Pacific and African fronts. They are used for fighting since they carry Stokes mortars and heavy machine guns, as well as 100-pound bombs, and have a range up to 500 miles with an altitude averaging about 1,000 feet. They are also used for observation in place of the old-type balloons, for courier duty, auxiliary scouts and as advanced guards by the striking forces. In peacetime these planes were the well-known Piper Cubs, Aeroncas, Taylor Crafts, Fairchilds and Stinsons.

The giant strides made by the airplane industry are at least matched by the oil industry in producing the 100 and higher octane gasoline and the necessary lubricants to operate the hundreds of thousands of aviation engines.

There are many chemical processes involved in the production of our aviation gasoline. The 100-octane gasoline is a 100 per cent. development of the oil industry of the United States. We have far superior aviation gasoline and lubricating oils than the Axis powers have available. The octane ratings of aviation gasoline which were collected from shot-down German planes averaged about 87. It has been reported that the German invasion of England in September, 1940, was stopped by the R.A.F. because their fighting planes were powered with 100-octane fuel, while the German planes were fueled with 87-octane.

The importance of high octane ratings in gasoline for airplanes is strikingly shown in the performance of 87-octane compared to 100 in a bombing plane, particularly as to speed, rate and time of climbing to maximum ceilings and maneuverability of the plane. Comparative tests of 87- versus 100-octane in a bombing plane showed that it took nineteen minutes to reach an altitude of 26,000 feet for 87-octane, whereas the 100 required only twelve minutes. The absolute ceiling of the plane in round numbers was 37,000 versus 33,000 feet for the lower octane-fueled plane.

The newest transport plane, called the Constellation, just tested, will carry fifty-two passengers with a speed greater than the Japanese Zeros. The plane can fly at about a seven-mile ceiling far above storm conditions, while ordinary cruising altitudes are about four miles. The Constellation can cross our continent in one eight-hour hop using more than 8,000 horsepower with the remarkably low fuel consumption of one gallon of gasoline per mile.

CONCLUSION

World War II may not be a total loss for humanity. A tempo never before attained in the United States has been reached with a collaboration and exchange of knowledge between heretofore highly competitive groups. New materials now in war production will have great peacetime values. We will also have access to a vast amount of knowledge and experience which has been accumulated as the result of hectic years of war. Man's life will be prolonged, his health, mentality, imagination, and productivity increased, and the pain and irritations of life will be reduced to a minimum.

OBITUARY

OSKAR BOLZA

NEWS has recently reached mathematicians in America through the American Red Cross that Oskar Bolza passed away peacefully in Germany on July 5, 1942, at the age of eighty-five years. He emigrated to this country in 1888, was one of the founders of the Chicago Section of the American Mathematical Society and a member of the National Academy of Sciences, and had great influence on the development of mathematics in America during his residence here from 1888 to 1910.

He was born on May 12, 1857, in Bergzabern in the Palatinate of the Rhine. The fortunes of his family were considerable, due to the exploitation in 1817 of an invention of a rapid printing press by his maternal great-great-grandfather, Friedrich Koenig. So far as is known he was free throughout his life from financial worries. In 1873 his father, who had retired from his position in judicial service, moved his family to Freiburg-im-Breisgau, and from that time this city was Professor Bolza's German home city to which he returned for a part of almost every year.

As a young student Bolza was interested primarily in languages and comparative philology. But in an academy at Neuchatel under a Frenchman named Terrier, and in the Gymnasium at Freiburg under a professor named Koch, he studied what we would call college mathematics. Both of these men were inspiring teachers, and Bolza's experience with them became decisive for his whole life. His enthusiasm for mathematics grew to be a dominant one, while his interest in languages took a secondary position.

At the University of Berlin, which Bolza entered in 1875 at the age of eighteen, it soon became evident that he would be much more interested in a scientific career than in the family printing press factory which had long been managed by two of his uncles. After some hesitation over theoretical physics he decided in 1878 to devote himself to pure mathematics. Due to his own conscientiousness, and probably partly to his financial independence, his university student career was a long one. He studied at the University of Berlin under Kummer, Kronecker and Fuchs, and notably under Weierstrass in the famous course on the calculus of variations which Weierstrass gave in 1879. This course proved to be perhaps the most potent influence in forming Bolza's mathematical interests, though his doctor's dissertation was written in a different field. In other years he studied at Göttingen under Schwarz and Klein, and his dissertation on the reduction of hyperelliptic to elliptic integrals was finally approved by Klein in 1888. His examination for the Ph.D. was successfully passed in the same year when Bolza was twenty-nine years old.

The problem of a profession was a serious one for Bolza. Two of his intimate student friends, the mathematician Heinrich Maschke and the physicist Franz Schulze-Berge, had both reluctantly taken positions as gymnasium instructors. There did not seem to be opportunities in Germany for the three friends as lecturers in a university. Bolza had been rejected for military service because of his rather delicate physique and he dreaded the twenty hours a week of teaching required in a gymnasium. Fortunately at this stage, in 1887, Schulze-Berge came to the United States and promptly secured a position as an assistant in Thomas Edison's experimental laboratory. His enthusiastic recommendations and the persuasiveness of two American professors, M. W. Haskell and F. N. Cole, who were then students in Göttingen, decided Bolza to take a chance in the New World. In April, 1888, he joined his friend Schulze-Berge in New Jersey, and shortly thereafter he was appointed reader in mathematics at the then youthful Johns Hopkins University. A year later he was appointed "associate" at Clark University, which opened its doors for the first time on October 1, 1889.

Clark University had been founded as a graduate school. In a few years it had financial difficulties which led to unhappiness and dissension in the faculty, as a result of which a number of them were quite ready to accept positions at the still newer University of Chicago which opened on October 1, 1892. Bolza was invited to join this group and he persuaded President Harper of the new university and Professor E. H. Moore, the head of the department of mathematics, to appoint both himself and Maschke as associate professors, Maschke having meanwhile also come to the United States. Bolza took up his new duties on January 1, 1893, and after one year was made a

full professor, in accordance with an earlier agreement.

The combination of Moore and Bolza in analysis, and Maschke in geometry, was a strong one at the University of Chicago. The university became at once one of the leading graduate schools of mathematics in America and its students are widely scattered in the departments of mathematics of American universities. Many of us owe our interest and training in mathematics to Bolza in particular, though every one who studied at Chicago at that time must also have been greatly influenced by Moore and Maschke. They were all three most able scholars and skilful lecturers.

In 1908 Maschke died, and the Chicago environment became a very sad one for Bolza. Their friendship from student days had been an ideal and very intimate one. This sadness, together with the fact that his mother in Freiburg was very old and seemed to have at most a few years more to live, were undoubtedly most influential in deciding Bolza to return to Freiburg permanently. But he himself has said that he was also much influenced by the feeling that by that time there were many younger men well trained in mathematics in America, and that he should make way for some of them. He was also interested to find that he would be appointed at the University of Freiburg to an honorary professorship which would permit him to lecture on mathematics as much or as little as he desired. So in June, 1910, after eighteen years at the University of Chicago, Bolza was appointed non-resident professor of mathematics there and returned to Germany with, as he himself wrote, "warm feelings of thanks and admiration for this country, which at a critical time in my life had given me the opportunity to develop my possibilities and follow my inclinations."

As honorary professor at the University of Freiburg Bolza continued at a moderated pace his lectures on a variety of mathematical subjects and his mathematical research. In the summer quarter of 1913 he lectured again at the University of Chicago and renewed with great pleasure his friendships in America. The first world war of course disturbed him greatly and in the end cut short his research activity in mathematics. In 1922 at the age of sixty-five he gave up his mathematical research, and in 1926 he interrupted his lectures at the University of Freiburg.

At this time he became interested seriously again in languages, especially Sanskrit, and in religious psychology. In the latter field he published a book entitled "Glaubenslose Religion" under the pseudonym F. H. Marneck. It was an absorbing interest during the latter part of his life.

He had one last return to his lectures on mathematics at the University of Freiburg during the years 1929–1933 and then gave them up finally at the age of seventy-six. Just about that time one of his earlier and most intelligent Ph.D. students, J. H. McDonald, of the University of California, visited him for several weeks in Freiburg. A result of this visit was a renewed interest in the theory of the transformation of hyperelliptic to elliptic integrals. Bolza wrote and published in 1933 on this subject his last mathematical paper.

Bolza's principal mathematical interests were in the reduction of hyperelliptic integrals to elliptic integrals (eight papers), elliptic and hyperelliptic functions (seven papers), and the calculus of variations (twenty-eight papers). In these fields, and others of lesser interest to him, he made important contributions. In the calculus of variations especially he has been a most notable contributor, and his principal book on the subject, entitled "Vorlesungen über Variationsrechnung," published in 1909, is an example of the finest scholarship, indispensable to every one interested in the field.

Thus has passed a potent figure in American and European scholarship, a brilliant lecturer and a man beloved by his students and colleagues. At the suggestion of one of his former students he wrote and published privately in 1936 an autobiography of about forty-five pages entitled "Aus meinem Leben." It is a most interesting document, now in the hands of many of his mathematical students. From it was taken much of the material in the preceding paragraphs.

G. A. Bliss

RECENT DEATHS

Dr. Carl C. Brigham, professor of psychology at Princeton University, died on January 24, at the age of fifty-two years.

Dr. George Boris Karelitz, professor of mechanical engineering at Columbia University, known for his work on lubrication, died on January 19 at the age of forty-eight years.

Dr. John Rathbone Oliver, formerly professor of the history of medicine at the Johns Hopkins University, died on January 21, at the age of seventy-one years.

Dr. Winford Lee Lewis, inventor of lewisite gas, until 1924 professor of chemistry and head of the department at Northwestern University, later director of the Scientific Research Institute of the American Meat Packers Association, died on January 20. He was sixty-four years old.

WILLIAM MASSEY CARRUTH, for twenty-six years Samuel F. Pratt professor of mathematics at Hamilton College, died on January 23, at the age of sixty-three years.

DR. HERMANN JOHANNES BOLDT, emeritus professor of gynecology of the New York Post-Graduate School of Medicine of Columbia University, died on January 13, at the age of eighty-six years.

DR. JAMES MARSHALL BRANNON, assistant professor and assistant chief in dairy bacteriology at the College of Agriculture of the University of Illinois, died on January 21, at the age of sixty years.

SCIENTIFIC EVENTS

MICROFILM RECORDS OF THE LINNEAN COLLECTIONS AND MANUSCRIPTS

THE Carnegie Corporation of New York in April, 1941, made a grant to the Linnean Society of London to enable that organization to prepare a photographic record of all the extant Linnaean natural history specimens, and the Linnaean manuscripts in the possession of that society. After surveying the possibilities, the council of the Linnean Society decided to have microfilm records made. In making its appeal for a grant, the council of the society agreed to deposit a complete set of the proposed photographic records in some American institution. It has actually exceeded this condition in that after the microfilm records were made, two sets of positives were delivered to the Arnold Arboretum, each containing about 60,000 exposures. The ultimate plan is to deposit complete or partial sets in selected European and Colonial institutions.

The council of the Linnean Society selected Harvard University as the place of deposit of one set and directed the delivery of the second set to the Smithsonian Institution. Thus two American institutions benefit through this action of the Linnean Society and through the generosity of the Carnegie Corporation in making a grant to cover the cost of preparing this extensive microfilm record.

The Harvard University set, in so far as it appertains to botany, will be deposited at the Gray Herbarium, and the remainder at the Museum of Comparative Zoology. The second set has been delivered to the Smithsonian Institution. A very extensive series represents all the specimens in the Linnaean Herbarium, while other rolls represent the insects, molluscs and fishes in the Linnaean collections. An even larger part of the microfilm record represents Linnaean manuscripts and his published texts wherein he had made corrections and additions.

Arrangements will ultimately be made whereby specialists in other institutions may be able to have access to this most important record. All biologists realize the fact that the Linnaean collections are absolutely basic to the binomial system of nomenclature and that in order to interpret various Linnaean species it is essential that his material be examined, either the original specimens or photographic records of them.

E. D. MERRILL

ASSETS OF THE UNIVERSITY OF MICHIGAN

ASSETS of the University of Michigan amounted to $83,014,263 for the fiscal year ending June 30, 1942, according to the annual financial report of Shirley W. Smith, vice-president and secretary, which has been approved by the University Board of Regents.

This year's total is an increase of $3,054,708 over last year, with the greatest rise shown in current assets—cash, including restricted expendable gifts, student loans, inventories, etc., which jumped $1,258,281, and plant and endowment funds which rose $848,928 and $683,379, respectively.

The total value of the educational assets, including lands and buildings, this year is $59,972,085, a rise of $823,988. The increase was largely in equipment and buildings whose value rose $384,119 and $323,404, respectively, over the figures for 1941.

The increase of $105,454 in lands is due to the purchase of the site for the Rackham Memorial Building in Detroit, partially offset by the sale of property in Ann Arbor, various transfers and reallocations. Increase in the amount for buildings is due principally to the completion costs of $175,582 for the Rackham Building in Detroit and initial construction costs of $143,615 for the School of Public Health Building.

Current operating income of the university was listed at $12,100,716, which includes $2,452,334 hospital receipts, or 20.27 per cent. of the total amount. State appropriations of $4,972,084 were the chief items of income, amounting to 41.09 per cent., while student fees amounted to $2,292,199, or 18.94 per cent. The only other appreciable item of current income is the total of $1,328,089 in gifts and grants for current use, or 10.97 per cent. of the total. The four other receipt items were each less than five per cent.

The current operating expenditure reached $10,702,896 this year, with the outstanding item of expense being $4,974,710 or 46.48 per cent., for instruction, followed closely by the University Hospital, which cost $2,420,522, or 22.61 per cent. of the grand total. Only one of the other nine items of expense

stands out, that being the operation and maintenance of the physical plant at a cost of $987,970, or 9.23 per cent. All other expense items are each less than 6 per cent. There remained, however, fairly large unexpended amounts of gifts and grants for purposes restricted by the donors.

University trust funds increased $1,662,012 over last year's total, with the total figure listed at $20,-399,040, as compared with $18,737,028. Endowment funds in the hands of the university were $13,179,025, and in the hands of the state treasurer, $550,744, with an additional $2,130,700 in trust. The increase in endowment funds is largely due to the $400,000 Horace H. Rackham Fund addition, the original gift amounting to $4,000,000. Student loan funds were $687,836, agency and deposit funds amounted to $1,778,404, and expendable funds were $2,072,330.

THE WAR-TRAINING CENTER OF NEW YORK UNIVERSITY

NEW YORK UNIVERSITY has transformed its 50-acre campus at University Heights into a war-training center for engineering, science and related activities. Plans are now in operation, according to Chancellor Harry Woodburn Chase, to expand and consolidate war-training efforts through the establishment of a coordinated program to be directed by Dr. Thorndike Saville, dean of the College of Engineering. Courses in the University College of Arts and Pure Science, under Dean William B. Baer, will give right of way to students preparing for vital war service. Such portions of its program as can no longer be cared for at University Heights will be continued at the Washington Square center for the duration of the war.

The teaching staff and technical facilities of the engineering college are being called upon to train increasing numbers of cadets and enlisted men of the Air Corps in meteorology, to conduct specialized classes for various other branches of the military forces, and to give intensive courses for the personnel of war industry. Furthermore, preparations are being made to accept additional men in uniform who are likely to be sent for training in engineering, science and pre-medical studies.

To meet the directives of the War Manpower Commission it is equally important to maintain the training of regular undergraduate and graduate students in engineering, and those enrolled in pre-medical, predental and science majors. These programs will be continued. The organization at University Heights will enable activities to be coordinated, and will provide for some 2,500 full-time day students.

In addition evening classes will be conducted for about 1,500 civilians under the program sponsored by the Government for war training in engineering, science and management. There will be at least 800 regular degree students in the evening and graduate divisions. During the second semester it is expected that nearly 5,000 students engaged in studies directly concerned with the war will be trained.

A research program in the technological as well as the pure sciences engages the facilities of every department. The wind-tunnels of the Guggenheim School of Aeronautics, as well as the laboratories in other branches of engineering science, are now being utilized for wartime research.

A new mess hall for the use of Army and Navy personnel is being constructed. Facilities will be available for the complete housing, feeding, drilling and training of the men.

The Washington Square College of Arts and Science, despite its own emphasis on war work, will maintain a full liberal arts curriculum. Its special war courses include cryptography-cryptanalysis, radio communications, foreign languages and the basic and pre-professional sciences required by the armed services.

In addition to the concentration of war work at University Heights, the downtown center at Washington Square will offer programs related to the war in the fields of education, liberal arts and business, as well as in public service. Dean Charles Maxwell McConn will supervise the arts and science curricula, which in the second semester will offer an accelerated program for entering men and women freshmen which will enable them to complete their degree requirements in two years and eight months; a one-year pre-induction course for seventeen-year-old male freshmen; an accelerated pre-medical and pre-dental program, and evening pre-induction war service courses.

The School of Commerce, Accounts and Finance, under the direction of Dean John T. Madden, will add to its regular business curriculum on February 1 an intensive six-weeks evening program for men and women seeking war work and for others already employed who want to improve their skills.

AWARD OF THE RESEARCH COUNCIL ON PROBLEMS OF ALCOHOL

THE Research Council on Problems of Alcohol has announced an award of $1,000 for "outstanding research on alcoholism during 1943." The work must contribute new knowledge in some branch of medicine, biology or sociology important to the understanding or prevention or treatment of alcoholism. Citizens of the United States, Canada or Latin America are eligible for the award.

The project may have been inaugurated at any time in the past or during the year 1943, provided (a) that a substantial part of the work be carried on during the year 1943; (b) that it be developed to a point at which significant conclusions are possible before the

end of the year, and (c) that a report on the work has not been previously announced and described before a scientific body or previously published. It is desirable, but not necessary, that those planning to work for the award send to the council before March 1, 1943, a statement of such intention. A report of the work and resulting conclusions must be submitted to the Research Council on Problems of Alcohol on or before February 15, 1944.

The Committee of Award will consist of five members—an officer of the American Association for the Advancement of Science, and four representatives of the Scientific Committee of the Research Council on Problems of Alcohol.

If the committee is not convinced of the outstanding merit of the research done during 1943, as described in reports submitted, it may, at its discretion, postpone the award for another year, or until such time as work of such merit has been performed.

THE NEW YORK MEETING OF THE OPTICAL SOCIETY OF AMERICA

THE mid-winter meeting of the Optical Society of America will be held at the Hotel Pennsylvania in New York, N. Y., on March 5 and 6. The Inter-Society Color Council will meet on Thursday, March 4, for a discussion in the morning and a business session in the afternoon. On Friday morning, March 5, there will be held a symposium of invited papers on "Vision" as follows:

"Factors in Human Visual Resolution," by Gordon L. Walls, Bausch and Lomb Optical Company.

"Some Physiological Aspects of the Eye as an Image-Forming Mechanism," by Kenneth N. Ogle, Dartmouth Eye Institute.

"Dark Adaption: Some Physical, Physiological and Clinical Considerations," by Charles Sheard, The Mayo Foundation.

"Some Factors and Implications of Color Constancy," by Harry Helson, Bryn Mawr College and The Foxboro Company.

An informal dinner will take place in the evening, followed by a lecture on "Visual Processes and Color Photography" by Ralph M. Evans, of the Eastman Kodak Company.

A second symposium on "Color-Blindness and Color-Blindness Tests" (arranged by the Inter-Society Color Council) will be held in the morning of March 6. The subjects of the papers and the authors are:

"Facts of Color-Blindness," by Deane B. Judd, National Bureau of Standards.

"Methodology of Test Preparation," by Forrest Lee Dimmick, Hobart College.

"The Evolution of Color Vision Tests," by Elsie Murray, Cornell University.

"The Red-Green-and-Yellow Equation for Normal and Color-Blind Observers," by Selig Hecht, Simon Schlaar and James C. Peskin, Columbia University.

"Hue Discrimination Test for Anomalous Color Vision," by David L. MacAdam, Eastman Kodak Company.

"A Method of Testing Color Vision Using Colored Transparencies and Standard Conditions of Observation," by Frederick W. Jobe, Bausch and Lomb Optical Company.

"The Farnsworth-Munsell 100-hue and Dichotomous Tests for Color Vision," by Dean Farnsworth, New York University.

"The ISCC Single Judgment Test for Red-Green Discrimination," by LeGrand H. Hardy, Institute of Ophthalmology.

Contributed papers will be presented in the afternoons of both days.

ELEMENT NO. 85

RECENT press dispatches from Bern, Switzerland, report the identification of element 85 as a disintegration product of radium. The work was done by Dr. Walter Minder, director of the Radium Institute at Bern, and Dr. Alice Leigh-Smith, an English expert in nuclear physics who has been studying cancer at the institute. Among the disintegration products of radium, these workers found traces of a compound which appeared to contain a radioactive form of element 85. Their recent work has succeeded in increasing the amount available, and now the announcement is made of the photographic identification of the element. The name anglo-helvetium is proposed in honor of England and Switzerland.

It will be recalled that the discovery of element 85 was announced in 1931 by Professor Fred Allison, of the Alabama Polytechnic Institute. By using the magneto-optic apparatus he found traces of the element, which he named alabamine, in sea water, in samples of potassium bromide and in such minerals as kainite, apatite and fluorite.

SCIENTIFIC NOTES AND NEWS

DR. A. W. HULL, of the General Electric Company, has been elected president of the American Physical Society in succession to Dr. P. W. Bridgman, Hollis professor of mathematics and natural philosophy at Harvard University. Other officers elected were Dr. Arthur J. Dempster, of the University of Chicago, *vice-president;* Dr. Karl K. Darrow, of the Bell Telephone Laboratories, *secretary,* and Dr. George B. Pegram, of Columbia University, *treasurer.*

PROFESSOR G. W. STEWART, of the State University

of Iowa, was presented with the Oersted Medal at the New York meeting of the American Association of Physics Teachers, which was held in conjunction with the American Physical Society. The medal is given for eminence as a physics teacher.

THE Robert M. Losey Award of the Institute of Aeronautical Sciences has been conferred on Commander F. W. Reichelderfer, chief of the U. S. Weather Bureau, "in recognition of his outstanding contributions to the science of meteorology as applied to aeronautics."

IN a recent issue of SCIENCE there was a note stating that Dr. Eugene L. Opie had returned to Cornell University Medical College to take charge, in the absence of Dr. William Dock, who recently entered the Army, of the work of the department of pathology. Dr. Opie is devoting part time also to the Henry Phipps Institute, Philadelphia, as temporary director of the laboratories.

A VICTORY ship of the California Shipbuilding Corporation has been given the name of George E. Hale, the distinguished astronomer who died in 1938.

DONALD BERTRAND TRESIDDER, M.D., president of the Board of Trustees and an alumnus of Stanford University, has been appointed to succeed Dr. Ray Lyman Wilbur, who was elected president in 1916. Since June, 1941, Dr. Wilbur has been chancellor and acting president of the university.

DR. GAYLORD P. WHITLOCK, who received the Ph.D. degree in agricultural and biological chemistry at the Pennsylvania State College in December, 1942, has joined the research staff of the department of dairy industry at the Iowa State College at Ames.

DR. MARGARET H. FULFORD, assistant professor of botany at the University of Cincinnati, has been appointed the recipient of a summer fellowship established for one year through a gift of Mrs. Elon Huntington Hooker. The fellowship was given to perpetuate the memory and work of Dr. Marshall A. Howe, who was for thirty-five years a member of the staff of the New York Botanical Garden and for the last two years of his life its director.

DEAN IVAN C. CRAWFORD, of the College of Engineering of the University of Michigan, has been named technical adviser and consultant to the Training Division of the U. S. Navy. Dean Crawford's services are being loaned to the Navy. He will return to the university a few days each month to carry on his administrative work in the College of Engineering.

DR. E. E. NAYLOR, assistant professor of botany at the University of Missouri, has become a technical assistant on the staff of the New York Botanical Garden.

GLENN L. MARTIN, president of Glenn L. Martin Company, has been elected president of the Aircraft War Production Council. He succeeds Guy W. Vaughan, head of Curtiss-Wright Corporation.

S. CAPLAN, who for the past nine years has been associated as research chemist with the Harvel Research Corporation, has become the research manager and acting technical director of the Irvington Varnish and Insulator Company at Irvington, N. J. He succeeds C. F. Hanson, who has been appointed chief consulting engineer. He will be responsible for expediting technical work on war production.

DR. MAURICE L. TAINTER, professor of pharmacology at the Stanford University School of Medicine, has been named state gas officer for California by the State Council of Defense Emergency Medical Service. Dr. Tainter set up San Francisco's gas treatment and protection services for civilian defense.

DR. HAROLD T. COOK, plant pathologist at the Virginia Truck Experiment Station, Norfolk, Va., has been commissioned Lieutenant in the Navy Reserves.

DR. WILLIAM B. HERMS, professor of parasitology and head of the Division of Entomology and Parasitology of the University of California, has been called to active duty by the War Department as Lieutenant-Colonel in the Sanitary Corps. He has been a Reserve Officer since 1924 and has been called for duty at the Army Medical Field Service School, Carlisle Barracks, Pennsylvania. He will be instructor in tropical medicine, having specialized in work on malaria, typhus fever and other diseases of the tropics. Professor E. O. Essig, professor of entomology, will act as head of the division during Professor Herms's absence.

DR. J. STANLEY GARDINER, F.R.S., emeritus professor of zoology at the University of Cambridge, has been appointed a member of the British Standing Commission on Museums and Galleries in the room of the late Sir Henry Miers, F.R.S.

ROBERT RAE, professor of agriculture at the University of Reading, England, and joint director of the Agricultural Research Institute at Hillsborough, Ireland, is visiting the United States. He will make a study of agricultural colleges and field organizations.

JOHN H. PIERCE left New York on January 12 on a wartime assignment to Colombia, Venezuela and Brazil for the Pan-American Products Corporation. He will collect and make a survey of certain plant products that are needed in war production.

THE sixth Christian Fenger Lecture of the Institute of Medicine of Chicago and the Chicago Pathological Society will be delivered on February 8 by Dr. William H. Taliaferro, Eliakim Hastings Moore distin-

guished service professor of parasitology and dean of the Division of Biological Sciences of the University of Chicago. He will speak on "Antigen-Antibody Mechanisms in Immunity to Metazoan Parasites."

DR. O. D. VON ENGELN, professor of geology at Cornell University, gave the Bownocker lectures of the department of geology at the Ohio State University on the afternoons of January 21 and 22. He also addressed the Ohio State Chapter of the Society of Sigma Xi on the evening of January 21. The subjects for the afternoon lectures were "The Nature of Glaciers" and "Two Schools of Geomorphology." The subject for the evening lecture was "Terrain and War."

DR. JOHN L. RICE, president of the American Public Health Association for 1942 and formerly commissioner of health of New York City, has joined the staff of Lederle Laboratories as consultant.

PROFESSOR CARL G. HARTMAN, of the department of zoology of the University of Illinois, spoke on January 13 at Iowa State College on "Instinctive Behavior."

AS announced last year two symposia are being organized by the American Physiological Society: "Special Senses in Relation to War Problems" by Dr. Hallowell Davis and "Physiological Aspects of Fitness in Relation to War Problems" by Dr. Maurice B. Visscher. These will be published in the second and third numbers of "Federation Proceedings" with similar material from other societies. It is not planned to have them orally presented at any regional meeting.

THE Johns Hopkins Medical History Club will hold its second meeting of the year on Monday, February 1, at 8:30 P.M., in the Institute of the History of Medicine. A paper on "Superstition and Medical Progress" will be given by Dr. E. B. Krumbhaar, of the University of Pennsylvania, and one on the "History of our Knowledge of the Lymphatic Vessels," by Dr. George W. Corner, of the department of embryology, Baltimore, of the Carnegie Institution of Washington.

THE next meeting of the trustees of the Elizabeth Thompson Science Fund will be held in April. Previous awards from the fund were reported in SCIENCE on June 19 and earlier. Applications for grants should be made to the Secretary, Dr. Jeffries Wyman, Biological Laboratories, Harvard University, Cambridge, Mass.

THE Supreme Court on January 18 upheld the conviction of the American Medical Association and its affiliated Medical Society of the District of Columbia on charges of seeking to restrain the operations of the Group Health Association, Inc., a Washington medical service cooperative, in violation of the Sherman anti-trust law forbidding restraint of trade. The indictments accused the two medical organizations of seeking to restrain the cooperative in supplying—through monthly salaried full-time employee doctors—medical care to its members and their dependents; to restrain members of the Group Health Association from obtaining such medical care; to restrain Group Health Association doctors; to restrain other doctors in the pursuit of their calling and, finally, to restrain Washington hospitals.

A NEW editorial board has been announced for *Endocrinology,* its members being J. S. L. Browne, department of medicine, McGill University; E. T. Engle, College of Physicians and Surgeons, Columbia University; Carl G. Hartman, department of zoology, University of Illinois; E. C. Kendall, Division of Biochemistry, Mayo Clinic; F. C. Koch, department of biochemistry, University of Chicago; C. N. H. Long, department of physical chemistry, Yale University School of Medicine, and H. B. van Dyke, Squibb Institute for Medical Research. The managing editor is E. B. Astwood, of the departments of medicine and pharmacology, Harvard Medical School, and the associate managing editor, E. W. Dempsey, of the department of anatomy also of Harvard Medical School. A statement of new policies for the journal appears in the February issue of *Endocrinology.*

A RESEARCH fellowship in the department of chemistry at Lehigh University has been established by the West Vaco Chlorine Products Corporation to support research into the uses of active magnesia particularly as a catalytic agent. The grant, which carries a monthly stipend to the student of $60, has been guaranteed for two years and begins with the new semester on February 1. The work will be under the direction of Dr. Albert C. Zettlemoyer, instructor in physical chemistry.

THE J. T. Baker Chemical Company has announced that its Eastern Fellowship for Research in Analytical Chemistry is open for 1943–44. The object of this fellowship is to encourage and to assist fundamental research in analytical chemistry. The recipient will receive $1,000 annually and will be expected to devote at least nine months to research in an institution conferring the Ph.D. or Sc.D. degree in chemistry in New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia or one of the New England States. The fellowship is awarded by a committee consisting of N. H. Furman, *chairman,* Princeton University; J. H. Yoe, *secretary,* University of Virginia; G. P. Baxter, Harvard University; H. A. Fales, Columbia University, and M. L. Nichols, Cornell University. A candidate for this fellowship must

possess a bachelor's degree or its equivalent and a broad training in the fundamental branches of chemistry. Applications should be sent to John H. Yoe, University of Virginia, Charlottesville, Va., not later than March 1. Further details will be furnished upon request.

THE London correspondent of the *Journal* of the American Medical Association writes: "The war has cut off the Scandinavian sources of material for making paper, and the supply of paper for the printing of periodicals and books is controlled by the government. The result is enforced economy in the consumption of paper. The first June issue of *The British Medical Journal* in 1941 contained only thirty-eight reading pages; in the corresponding issue of 1942 the number was reduced to thirty-two because the paper controller continues to cut the supply. Hence *The British Medical Journal* has made a further reduction in the size of the type and reduced the considerable space given to correspondence, and has enjoined conciseness on correspondents."

ATTENTION is called in a note printed in *Nature* to the extensive facilities available at the Imperial Institute, London, for the rapid supply of technical information relating to the trade, occurrence and utilization throughout the world of all kinds of raw materials, and the scope of the intelligence service is not so well known as they should be. The institute's staff includes tropical agriculturists, chemists, chemical technologists, economic botanists, economic geologists, mining engineers, mineralogists and statisticians, and, when desirable, the institute seeks the advice of members of its fifteen consultative committees. Further help is also afforded by numerous trade contacts. The institute also has an extensive reference library and a technical index covering most of the relevant trade and scientific publications issued during the past thirty years. The institute can deal with inquiries relating to sources of supply of, and other information relating to, raw materials and semi-manufactured products whether of animal, plant or mineral origin in all countries, cultivation of crops and the soil and conditions under which they have to be grown, methods employed in mining, smelting and dressing minerals for the market, and so on. Analysis and testing of samples of raw materials is undertaken in the laboratories of the institute. Inquiries should be made in the first instance to the Intelligence Section of the Plant and Animal Products Department or of the Mineral Resources Department, according to the nature of the subject concerned. No charge is made for services to departments of the United Kingdom Government or other Governments of the Empire contributing to the general funds of the institute unless a particular inquiry involves a volume of work so great that it can not be undertaken by the existing staff.

DISCUSSION

EFFECTS OF THE EARTH'S ROTATION ON THE RANGE AND DRIFT OF A PROJECTILE

THERE has been much discussion recently concerning the question: Does a projectile (or missile) move farther when fired to the east than when fired to the west? Some authors contend that the two distances traversed are the same, others that the distance to the east is greater than that to the west, and still others that the distance to the west is greater than that to the east.

Under the proper restriction each of these statements is correct. For, as we shall show below, if the angle of elevation of the gun were *just* 60° the two distances would be the same; if it were between 0° and 60° the distance to the east would be greater than that to the west, and finally if this angle were between 60° and 90° the distance to the west would be greater than that to the east.

In order to prove this, use will be made of some of the formulae which have already been derived by the author in his monograph entitled, "The Weight Field of Force of the Earth," published in Washington University Studies, New Series, Science and Technology, No. 11, 1940.

1st Proof: By a simple trigonometric transformation the second of formulae (129) on page 68 the range x of a projectile may be expressed in the form

$$\bar{x} = \frac{v^2_0}{g_1}\sin 2\beta + \Delta\bar{x}, \tag{1}$$

where

$$\Delta\bar{x} = -\frac{4\,v^3_0}{3\,g^2_1}\omega\cos\phi_1 \sin 3\beta \sin\alpha,$$

in which ω is the angular velocity of the earth's rotation with respect to the fixed stars, g_1 is the acceleration, due to weight, at the position of the gun, ϕ_1 is the astronomical latitude at the position of the gun, α is the azimuth (measured from the south through the west) of the direction of fire (*i.e.*, of the positive sense of the axis of x), β is the angle of elevation of the gun (measured upward from the direction of fire), v_0 is the muzzle velocity of the projectile. The ranges in value of the various angles are:

$$-90^\circ < \phi_1 < 90^\circ, \qquad 0^\circ \leqq \alpha < 360^\circ, \qquad 0^\circ < \beta < 90^\circ.$$

If the projectile be fired to the east, for which $\alpha = 270^\circ$ or $\sin\alpha = -1$, we have, in particular,

$$\overline{\Delta x} = \frac{4\,v^3_0}{3\,g^2_1}\omega \cos \phi_1 \sin 3\,\beta \begin{cases} > 0 \text{ for } 0° < \beta < 60°, \\ = 0 \text{ ``} \quad \beta = 60°, \\ < 0 \text{ ``} \; 60° < \beta < 90°, \end{cases}$$

with the positive sense of x to the east.

If the projectile be fired to the west, for which $\alpha = 90°$ or $\sin \alpha = 1$, we have, in particular,

$$\overline{\Delta x} = -\frac{4\,v^3_0}{3\,g^2_1}\omega \cos \phi_1 \sin 3\,\beta \begin{cases} < 0 \text{ for } 0° < \beta < 60°, \\ = 0 \text{ ``} \quad \beta = 60°, \\ > 0 \text{ ``} \; 60° < \beta < 90°, \end{cases}$$

with the positive sense of x to the west.

In both of these cases the *deviation in range* (*i.e.*, $\overline{\Delta x}$) extends to the east if $0° < \beta < 60°$, and to the west if $60° < \beta < 90°$, and this deviation is zero if $\beta = 60°$. The first term in formula (1), namely: $\sin 2\,\beta \cdot v^2_0/g_1$, represents distance from the gun to the east if $\alpha = 270°$, and to the west if $\alpha = 90°$. It is from the terminal points of both of these distance-vectors that $\overline{\Delta x}$ extends to the east if $0° < \beta < 60°$ and to the west if $60° < \beta < 90°$, and produces no augmentation if $\beta = 60°$. We have thus proved the statements made in the second paragraph.

2nd Proof: Let us refer the motion of the projectile to a set of cardinal axes $0 - \xi, \eta, \zeta$ of which the origin 0 is at the muzzle of the gun, and the positive senses of the axes of ξ, η, ζ are to the south, east and zenith, respectively. Denoting the time derivatives of the coordinates ξ, η, ζ by ξ', η', ζ', respectively, the components of the muzzle velocity-vector (v_0) are $\xi'_0, \eta'_0, \zeta'_0$. Again referring to the above mentioned monograph, we find that equations (115), on page 63, express the coordinates ξ, η, ζ of the moving projectile in terms of the time t. If we equate to zero the expression for the altitude ζ and solve the resulting equation for t, we obtain the expression (123), on page 66, for the time of flight of the projectile. Substituting this value of t in the first two equations (115), we obtain for the coordinates of the *point of fall*, the expressions

$$\bar{\eta} = \frac{2\,\eta'_0\zeta'_0}{g_1} + \frac{4\,\omega}{g^2_1}\left[\zeta'_0\{\eta'^2_0 - \tfrac{1}{3}\zeta'^2_0\}\cos\phi_1 - \xi'_0\zeta'^2_0 \sin\phi_1\right],$$

$$\bar{\xi} = \frac{2\,\xi'_0\zeta'_0}{g_1} + \frac{4\,\omega}{g^2_1}\eta'_0\zeta'_0\left[\xi'_0 \cos\phi_1 + \zeta'_0 \sin\phi_1\right].$$

If, in particular, the line of fire is along the east-and-west line (*i.e.*, along the axis of η), we have $\xi'_0 = 0$, and then the preceding formulae become

$$\bar{\eta} = \frac{2\,\eta'_0\zeta'_0}{g_1} + \frac{4\,\omega}{g^2_1}\{\eta'^2_0 - \tfrac{1}{3}\zeta'^2_0\}\zeta'_0 \cos\phi_1,$$

(2)

$$\bar{\xi} = \frac{4\,\omega}{g^2_1}\eta'_0\zeta'^2_0 \sin\phi_1.$$

Since now (*i.e.*, for $\xi'_0 = 0$) we have $\eta'_0 = v_0 \cos \beta$, $\zeta'_0 = v_0 \sin \beta$, (where β may now be regarded as measured from the positive η-axis and capable of ranging in value from 0° to 180°, so as to include the case in which $\alpha = 90°$ as well as that in which $\alpha = 270°$), the first of formulae (2) becomes the same as formula (1) when $\alpha = 270°$, and the second takes the form

$$\bar{\xi} = \frac{4\,v^3_0}{g^2_1}\omega \sin\phi_1 \cos\beta \sin^2\beta,$$

which is the same as the expression for the drift (distance of the point of fall from the line of fire) given by the third of formulae (129), page 68, of the monograph, for the special case in which $\alpha = 270°$ or $90°$.

The first of formulae (2) gives us the information we desire. For since $\zeta'_0 > 0$, it follows that the first term changes sign with η'_0 (since it enters to the first degree), whereas the second term *does not* change sign with η'_0 (since it enters to the second degree). Furthermore, the second term is positive, negative or zero according as

$$\eta'^2_0 - \tfrac{1}{3}\zeta'^2_0 = v^2_0 (\cos^2\beta - \tfrac{1}{3}\sin^2\beta) = v^2_0 (1 - \tfrac{4}{3}\sin^2\beta)$$

is positive, negative or zero, *i.e.*, according as the angle of elevation β is less than, greater than or equal to 60°.

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SUGGESTED CASTE TAXONOMY FOR THE COMMON TERMITE

FOURTEEN years have passed since the beginning of the work of the Termite Investigation Committee under Drs. C. A. Kofoid and S. F. Light, of the University of California. Early in the work, good fortune permitted my selecting as a subject of study the genus *Reticulitermes* with a caste system, more complex than that of any other wide-spread Nearctic genus of termites. I used, of course, the regular caste taxonomy of the time. Primary, secondary and tertiary reproductives were each studied as a caste. But long-time collecting yielded a series of specimens bridging the gap between the primary reproductive and the worker; the supplementary reproductives, far more prolific than the primary, gradually assumed, in a new line of thinking, the status of an intercaste. Nanoids, both soldiers and workers, were found, and at first were recorded as castes; then rare intermediate soldier-workers and still rarer soldier-reproductives had to be classified. At last I came to feel that we who are interested in the complicated society of the termitarium might be "picking castes from the air." Independent work since has extended my laboratory observations to include the chief species of *Reticulitermes* in each of the termite-yielding sub-regions of the Nearctic. I find that given sufficient time, we can produce or at least predict the appearance of most of the outstanding forms found in the labyrinths. This brought not a "break with the old system" but a gradual drifting away from it. What I regarded as a caste, fourteen years ago, may now seem no more than subcaste or intercaste; instead of listing newly discovered sizes and forms, each in a separate caste, it seems better to seek to relate each to one of the three more common castes: Reproductives, workers

and soldiers. Interblendings of these and maturity attained in different instars by different individuals would seem to account for all other forms and sizes, remembering, of course, the absence of nasutes in *Reticulitermes*. In *South Carolina Natural History* (No. 29, 1937) the existence of intermediates and subcastes is indicated, but I did not feel free to break completely with the idea of supplementaries and nanoids as castes. In *Neighborhood Research* (2: 3, 1938) I am inclined to treat secondary, tertiary and soldier-like reproductives as well as soldier-workers as intermediates of the three regular castes, and in the same publication (4: 1, 1940) I have outlined the scheme of classification of castes I am still using in my study of *Reticulitermes,* save for the substitution of what seem better names for some of the forms observed. Thus all forms have been found capable of relation to this classificatory scheme:

CASTE 1. Primary, primitive or archaic reproductives; the "king and queen" or "royalty" of older writers. Fully winged previous to mating and thoroughly pigmented.

Intercaste 1. Supplementary reproductives; "vice-royalty"; "secondary" and "tertiary" reproductives; brachypterous and apterous reproductives; neoteinics. Most of the forms here will be found to be the white "brachypterous" type. The older lines are too hard and fast; a gradual transition in form may be traced from the primary reproductive to what is apparently the worker form. We should here include all below the perfectly winged type and all above the infertile worker, in a broad reproductive-worker intercaste.

CASTE 2. Workers; ergatoids. Wingless individuals who do the labor. They are found in four sizes, which have been termed sub-castes:

- i. Midgets, or Nanoids, apparently adult at fifth instar
- ii. Dwarfs, or Parvuloids, apparently adult at sixth instar
- iii. Regulars, or Megaloids, apparently adult at seventh instar
- iv. Giants, or Gigantoids, apparently adult at eighth instar

Intercaste 2. Worker-soldier or soldier-worker form. Known, so far only in the midget, and perhaps the dwarf form, but only one size positively known. Thus division into sub-intercastes is not justified. For sake of a different initial in graphs I have called this intercaste form the *guerrilla,* which word bears a suggestion of the diminutive, or at least the "small-time" warrior.

CASTE 3. Soldiers; guards. Fighters, who are unable either to reproduce or to work. They occur in the four sizes, or subcastes, given above for workers.

Intercaste 3. Reproductive-soldier or soldier-reproductive. Known so far only in a larger size corresponding to the regular-sized or perhaps the giant-sized soldier or worker. I have termed this a *tiro,* following the Latin and Austin Dobson's spelling of the word, which originally signified a newly levied soldier, or beginner. It really seems to be the last of the known forms to make its appearance, and its tyro—using the common spelling—nature shows in its being both soldier and reproductive but doing neither well.

Let us take now the initial letter of each of the names given to castes and intercastes, *viz.,* A from the alate or better the archireproductive caste, N from the "neoteinic" or better the neoreproductive intercaste, and so: W, worker; G, guerrilla; S, soldier, and T, tiro, with E for the egg-mass deposited during the entire history of the community. Arrange them thus:

```
      A
T           N
      E
S           W
      G
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Some individuals hatching from E the egg-mass will develop through about seven stages to become alates, the youthful archireproductives. Many more will develop through five to eight stages or instars toward W to become workers. A smaller number, through a similar number of instars, grow toward S to become soldiers. Now can any one believing in the modern scientific ideas suppose that the eggs of the ancient roach-like termite following a normal course and producing individuals that developed along a straight course, which we may readily visualize as an unserifed, or Gothic, capital I, thus normally growing into reproductives like their parents, at some time suddenly began following some strange V-shaped path into reproductives and soldiers, and in later and higher termites an equiradiate Y into reproductives, soldiers and workers? Such a theory smacks too much of some force leading the insects along the mystic Pythagorean monad, duad and triad, shaped respectively like Gothic I, V and Y. Whether they arose by saltations or more gradual development true castes must have reached their more distinct forms through a line of intermediates more nearly like the primitive ancestors than appears at a later time. One group of these intermediates has proved so successful a deviation that most of the work of reproduction is carried on by it, and the primitive form has assumed a sort of secondary role in the matter of egg-laying.

In the rise and decline of a common termite community, each caste, intercaste and subcaste has apparently a place and time for its appearance approximating the exactitude with which dramatic players come

upon the stage for their parts. At swarming time the alates emerge, dealate themselves, sometimes after, sometimes without flight, and after pairing off and constructing a small cell begin a primary community. In *Reticulitermes* the diminutive nanoid worker is usually the first form to be distinguished as an offspring of one of these pairs. Soon after, however, we expect a nanoid soldier, and in those groups in which they appear the soldier-workers or "guerrillas" in nanoid size are due about the same time. In isolated groups there may be a delay in the arrival of new forms and sizes for even two years. Fortunately, however, several of these families may be neighbors, since the alates swarm often by thousands and rarely fly very far. A struggle now begins which we can liken only to a small war of imperialism. A number of parents may be killed off by invasion and their offspring annexed to a larger group headed by a surviving pair of reproductives. With more communal feeding parvuloid and megaloid workers and soldiers appear in order. The guerrillas or soldier-workers disappear, and with a larger population none of the soldiers nor workers become adults in the earlier instars, and so midget and dwarf forms yield to the larger sizes, and in very old and populous groups some appear to retain a sort of perpetual youth and to grow into an eighth instar, so becoming giants or gigantoids. But before this group arises the population has grown sufficiently to enable it to support a number of short-winged potential reproductives. I have found these within three years and six months from the time of the establishment of the original cell by the dealated primaries. Six months later, or four years after the spring in which the community began its history, the first swarm of alates issued, the cycle having worked back to the same form that established the said community. The soldier-reproductive or tiro remains unaccounted for. Apparently these arise from small groups of workers cut off from the main body and left without brachypterous potential reproductives. If we carefully hand-pick under the microscope a group of wingless workers and set them apart in a separate termitarium we may expect after a long period, as much even as ten months, a wingless or almost wingless reproductive to arise. At times, however, in such a group or perhaps in a remote part of the labyrinth a juvenile with a tendency toward the soldier form is apparently transformed into the reproductive before any worker can be so transformed. It is the rarest of the regularly recognized forms, and seems to occur only in one of the larger subcaste sizes. Note this carefully. While the soldier-worker or *guerrilla* is to be expected in the low populations of young and growing communities and in a smaller subcaste size, the soldier-reproductive or tiro is rather expected in the low populations of old and decadent communities and in a larger subcaste size. It would probably take years of experimenting, but it would be interesting to place the eggs of young primaries in these old, decadent groups to see if any of the resulting young developed into the reproductive-soldier form. Incidentally, it is quite likely that such eggs placed in a highly populous colony would not produce any of the lower subcastes, but that the young would grow into a larger size before becoming definitive workers or soldiers. Are guerrilla and tiro mere size variations or subcastes of the same form generations apart? At present, it seems better to regard these two intercastes as separate forms, both perhaps almost vestigial in *Reticulitermes,* but in a more primitive genus, *Zootermopsis.* Prof. G. B. Castle has found a number of fertile soldiers, the females capable of producing eggs, the males with large and well-developed testes (Kofoid and Light, "Termites and Termite Control," 1934). Some of the more tropical genera, still higher in development than *Reticulitermes,* have produced what I am inclined to regard as a fourth caste, the nasutes. Incidentally some nasutes have lost the mandibles, while on one hand others have long soldier-like mandibles, and on the other hand some have short mandibles that may relate them to the workers. Such genera it has not been my privilege to study closely in life, and I make the suggestion, merely as a possible explanation of the origin of the nasutes, worth at least a thought. Was the intercaste between the worker and the soldier which plays so little a part in the *Reticulitermes* group as to generally disappear early in the history thereof, retained in more advanced genera to be developed into other forms?

Anthropomorphism long troubled the zoologist; apimorphism still troubles the student of castes; too long he has been bee-minded. Apparently the worker-bees can make conditions that result in a "queen," but the termite reproductive evidently yields some secretion that inhibits the normal sex-development of its associates and keeps them in the condition of workers. Remove the reproductives, and others arise, which in turn secrete an inhibiting substance, that continues to hold the less forward individuals in the energetic but unfertile condition. As the colony grows, many succeed in wandering to parts of the labyrinth where they are free from this influence and so develop into normal reproductives. This increase of population, with more abundant intra-communal feeding, also allows the development of larger sizes of subcastes previously mentioned.

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A RECORD OF EMERITA ANALOGA FROM THE WASHINGTON COAST

During the spring and fall of 1941 and the summer of 1942 numerous sand crabs, *Emerita analoga* (Stimpson), were collected from the ocean beaches of Washington from the mouth of the Columbia River north to Kalalock. The localities include Long Beach, Grayland Beach, Copalis Beach and Kalalock Beach. They appeared to be especially common at Kalalock. Beaches north of the last locality have not been examined. The specimens ranged in size from postlarval stages with the carapace length of about 4 mm, to ovigerous females with a carapace length of 28 mm. Two male specimens collected were 11.5 and 13 mm long. The measurable characters of the specimens collected were well within the range of variation given by Schmitt.[1]

This species has never before been recorded north of Oregon, where it was reported from unspecified localities by Holmes.[2] Schmitt (*loc. cit.*) reports specimens in the U. S. National Museum from Drake's Bay, California, to San Bartolomé Bay, Baja California, in the northern hemisphere and from Peru to Chile in the southern.

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THE MICROMETER BURETTE

Arguments about priority are perhaps stupid and always embarrassing, but I regard the micrometer syringe with particular jealousy. I feel that the authors of the article entitled "Micrometer Burette" in Science, 96: 247, 1942, should have given a reference to the paper in the *Biochemical Journal,* 19: 1111, 1925, in which I described for the first time the application of the principle of their apparatus to biochemical work. The usefulness of the principle is emphasized by the number of times it has been redescribed with minor modifications both in England and America since I wrote the paper referred to.

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SCIENTIFIC BOOKS

ALCOHOL ADDICTION

Alcohol Addiction and Chronic Alcoholism. Vol. I. *Effects of Alcohol on the Individual.* Edited by E. M. Jellinek. Pp. 336. Yale University Press. New Haven, 1942. $4.00.

This first volume of a series of three to appear under the auspices of the Research Council on Problems of Alcohol presents by six authors, including the editor, a survey and analysis of the literature, with the declared purpose of clarifying the subject-matter as a basis for future research and for reference purposes.

The etiology and treatment of alcohol addiction are first received, the bulk of the book being then devoted to a description of some of the mental and bodily diseases of chronic alcoholism.

Some idea of the mass of material represented can be had from the statement of the editor that about 3,500 references among an estimated 100,000 bearing upon the topics of the projected three volumes were found to be worthy of consideration, because they were neither obsolete from the point of view of the medical sciences of 1941, nor primarily of propagandist character, nor were compilations producing no original opinions, nor duplicate presentations of already published data, and because they did deal with the effects of alcohol on the individual.

While there can be no precise distinction between the effects of alcohol on the individual and those related to his behavior or condition in society, the editor assures us that the "sociological aspects of inebriety" are not excluded from present consideration but only "'the effects of inebriety on society." In spite of the lack of any exact definitions of inebriety or of society as intended and used, it is fair to say that the spirit of the above distinction is followed in the half dozen chapters.

"Generally the scope of this work is the etiology of abnormal drinking; the effects of such drinking on the bodily and mental functions of the individual; and the immediate effects of alcohol in any quantity on the organs and their functions, and on psychological behavior." So far so good, but one searches in vain for the considered opinion of an author or the editor as to when drinking moves from normal to abnormal and what is the range of "normal" or "psychological" behavior in the user of alcoholic beverages. In both the Preface and in the introductory pages by the editor, there is a dearth of precise expressions but much language which leads to uncertainty of meaning. We are told that, in dealing with certain types of original articles, "the reviewers were justified in ignoring the verbalized conclusion of the investigator."

[1] *Univ. of Calif. Publ. Zool.,* XXIII, 1921, p. 173.
[2] *Calif. Acad. Sci. Occ. Papers,* VII, 1900, p. 103.

Physiologists, we are told, since they came to the problems of alcohol "from the theoretical frame of reference of physiology," have rarely made "longitudinal studies, which are prerequisite to the understanding of the process of addiction."

The following statement of attitude may be accepted as the editor's rather than that of the clinician authors. "On the whole, physiology, experimental psychology and clinical medicine have produced basic data, and psychiatry has furnished the necessary insight and working hypotheses, sufficient to warrant application of the existing knowledge to the investigation of the essential and complex problems of the origins of inebriety and addiction, their prevention and treatment." And this is the last the reader hears of prevention of alcohol addiction, of alcoholism or of abnormal drinking.

Part One, with two chapters by Karl Bowman and the editor on "Alcohol Addiction and its Treatment," and "Alcoholic Mental Disorders," and the related twenty pages of bibliography, is less effective or convincing as a source of facts and opinions of the past than are the four chapters of Part Two, perhaps because of the nature of the topics, but apparently more for the reason that the authors of chapters three to six express convictions based largely on direct personal knowledge of the current facts.

It is perhaps a merit in a reviewer to suppress his own views in giving the lessons of his predecessors, but something of definiteness could certainly have been said in regard to the etiology of alcohol addiction, even if its treatment remains the happy hunting ground of striking personalities and hopeful endeavorers. One gathers the impression that the etiology of alcohol addiction is clouded in a deepening obscurity.

Surely the clinical and time factors or criteria for "cure" of the alcohol addict are no more difficult to establish than are those for cancer or toxic hyperthyroidism, and yet we are left to flounder among tables of obviously non-comparable data in our efforts to discover any objective evidence of the results of various plans of treatment. One could wish the authors of Chapter I had expressed a bit of their own thoughts in the matter and spared us some of the confusion they reveal. We are told in substance only that more and better studies are needed and that effective psychotherapy must be made available to much larger numbers of addicts.

Chapter II is good, the topic lending itself to reasonably precise and accepted points of differential diagnosis and description. The field of alcoholic mental disorders has been tilled by men of acumen, imagination and wide experience and the gist of their facts and opinions is well presented.

Nowhere else than in Chapters III to IV of Part II can one find in medical literature in such convenient form, or so authoritatively expressed, the background, the present status and the immediate direction of further study of the topics dealt with.

Evidence, observation, critical discussion and conclusions are all admirably presented by Dr. Norman Jolliffe and his colleagues, the late Dr. Herman Wortis and Dr. Martin H. Stein, and by Dr. Giorgio Lolli. (III. Vitamin Deficiencies in Chronic Alcoholism, IV. Alcoholic Encephalopathies and Nutrition, V. Marchiafava's Disease, VI. Cirrhosis of the Liver.)

Here at least we are on a sound foundation, the meeting ground of clinician, pathologist and biochemist. Only in part of the last chapter on "Cirrhosis of the Liver" do we meet a rather inadequate and crude use of the statistics of morbidity and mortality. The usual techniques of correlation have not been used and there have been ignored some factors of tabulation, registration practice and incompleteness of reporting of deaths attributed to any form of alcoholism which certainly affect the validity of original data and the comparability of international death rates.

The undertaking of the three volumes is one of great difficulty, complex, little short of encyclopedic and beset by pitfalls in both fact and opinion. This first product of the Council's efforts shows courage and imagination. Volume II will deal largely with experimental material and the highly controversial matter of "germ damage." Volume III will deal with "the magnitude of the problem in terms of incidence, and will analyze the statistics presented in the literature."

Might the devotee of administrative medicine and public health enter a plea for a Volume IV to be devoted to evidence of changes in incidence of and mortality from acute and chronic alcoholism and in consumption of alcohol per capita, related directly or by inference to administrative measures of civil or military governments affecting the production and drinking of beverage alcohol, and some consideration of the actual cost to society of the burden of the alcoholic.

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OCEANOGRAPHY

Oceanography for Meteorologists. By H. U. SVERDRUP. xv + 246 pp. New York: Prentice-Hall, Inc. 1942. $3.50.

IN the solution of certain scientific problems and in carrying on of essential practical work, meteorologists connected with the present war have had an important share, as is evident from the repeated call of the United States Government for qualified persons in this field. A number of excellent meteorological texts have recently appeared to satisfy the needs of professionals and students alike. The book before us,

however, is of a different type because it is fundamentally on oceanography designed to aid the meteorologist in securing information bearing on problems of the atmosphere which physical oceanography can furnish. In this respect the volume fills a need not adequately met by any other work known to the reviewer.

Sea-surface elements and processes which affect chiefly the atmospheric conditions receive especial emphasis. Included among these are the physical properties of sea-water, surface-currents and the processes which maintain them. Adequate discussion is accorded salinity, temperature, pressure, eddy viscosity and conductivity of sea-water as well as the observations and instruments for their determination. The heat-régime of the oceans requires particular treatment, including the effect of radiation to and from the ocean, exchange of heat between the atmosphere and the sea, and evaporation from the sea, all related in a complicated way to meteorological factors and their variations thereby affecting world weather conditions. Nearly one half of the text is devoted to a consideration of oceanic circulation and its various aspects—the water masses (counterpart of air masses) and the great oceanic currents which influence so profoundly the climates of the earth.

As the author remarks, "The theoretical discussion of the dynamics of the ocean currents and the factual information from many ocean areas are as yet incomplete, and therefore it may be premature to generalize. Nevertheless, it has been attempted to overcome difficulties arising from differences in interpretation of incomplete data by placing emphasis on application of the equation of continuity in the description of the ocean circulation."

The necessity of further expeditions to obtain oceanographic data is thus emphasized. The voyages of the *Challenger, Meteor, Carnegie* and other vessels have greatly broadened our knowledge of the ocean, both physical and biological, but it is to be hoped that, at the conclusion of the present conflict, new expeditions may be sent out to gather data which will fill the gaps in our knowledge of the oceans and settle outstanding problems regarding their relations with the atmosphere.

The book is attractively printed and provided with good text-figures. Four folding charts on Goode's homolosine equal-area projection exhibit surface temperatures of the oceans in February and in August, surface salinity in northern summer and surface currents in February–March. No bibliographical references are given other than a list of eleven outstanding general works at the end of the preface.

To meteorologists interested in the interrelations of their specialty with oceanography the volume may be recommended without reserve. The unique experience of the author in oceanographical and meteorological research, both practical and theoretical, which has earned international recognition, has eminently qualified him to make this contribution to geophysics.

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ORGANIC CHEMISTRY

The Work Book of Fundamental Organic Chemistry. By ED. F. DEGERING and COLLABORATORS. 250 pp. New York: Barnes and Noble. 1942. $1.25.

THIS is intended for review work in organic chemistry and self-testing on the material of the given short summaries: also for self-testing on the material of a year course in organic chemistry. Each chapter contains (a) a review summary; (b) genetic charts in which the more important reactions of typical compounds are emphasized; (c) nomenclature, pronunciation and formula tables; (d) a composite review summary; (e) fill-in review questions, and (f) one or more objective tests. It is a compilation having distinct usefulness for students who desire to excel in organic chemistry, but it seems to this reviewer to be too comprehensive even for the excellent student. No purpose is served by burdening the memory of students with such a mass of detail in review material. I can imagine an excellent student getting 100 per cent. in each test, piece by piece, after reviewing a chapter, but I can not believe that the most learned teacher of organic chemistry could get more than 80 per cent. *in toto* without previous concentrated study for some time. But surely the purpose of a review book for students should be selection of material likely to be a minimum for certain specific purposes.

Fundamental Organic Chemistry. By ED. F. DEGERING and one hundred and six collaborators. Photo-offset. Planographed by J. S. Swift Co., Inc. Cincinnati, Ohio.

A TEXT-BOOK of 485 pages, of which 88 pages are devoted to a "kaleidoscopic survey" of organic chemistry with stress in relative electronegativity. The chapters in this first section of 88 pages are headed with figures, male and female, to represent positivity and negativity with respect to each other, the four valences of the carbon atoms which these figures represent being shown by their arms and legs. Thus methyl ethanoate is represented by a particularly hectic moment in a jitterbug contest of two drunken sailors and a dame, other compounds varying in "hectivity." The tables are very lightly printed. The electronic formulae are very confusing and are introduced too often. Photographs of Fisher-Hirschfelder models are scattered profusely throughout, together

with projections of pin models. Each chapter is headed in very thick type, which contrasts badly with the lightly printed tables and makes for strain in reading. The amount of descriptive material is more than adequate for a year course but the publication as a whole includes much unnecessary information (*e.g.*, "a new neoprene plant at Deepwater, N. J., established by E. I. du Pont de Nemours and Company, began operation in 1939"), many unnecessary models, figures and electronic formulae, and is not appealing in format. The analogy of negativity with femininity is not allowable in a civilization now reputed to be well on the way to a matriarchy.

GARFIELD POWELL

SPECIAL ARTICLES

THE VERATRINE ALKALOIDS. XIV. THE CORRELATION OF THE VERATRINE ALKALOIDS WITH THE SOLANUM ALKALOIDS[1]

FROM studies to be published elsewhere, evidence has been accumulating which has caused us to propose revisions of the older formulations of a number of the alkaloids of *V. album, viz.*, jervine, rubijervine and germine, which had been considered to be C_{26} compounds, to $C_{27}H_{39}O_3$, $C_{27}H_{43}O_2$ and $C_{27}H_{43}O_8$, respectively, so that like cevine, also $C_{27}H_{43}O_8$, they are C_{27} derivatives. Also, evidence has been obtained which suggests that they are built up, if not on a regular, at least on a modified sterol structure.[2] The fact that they are probably C_{27} derivatives is at once most suggestive in this respect.

The alkaloids of the solanum species, such as the alkaloidal aglycone solanidine of potato shoots, appear to have been definitely correlated with the sterols. Thus from the solanidine derivative, solanidiene, on dehydrogenation with selenium, Soltys and Wallenfels[3] reported the formation of the characteristic sterol degradation product, methylcyclopentenophenanthrene. Rochelmeyer[4] confirmed this and at the same time recorded a similar observation with solasodine. In the last instance, there was also obtained a pyridine base which was characterized as a picrate (m. p. 140–142°). However, its identity or homogeneity was not established and no analytical data were given.

It has now occurred to us that this base could have been identical with the 2-ethyl-5-methylpyridine which we have found to be a characteristic degradation product of all the veratrine alkaloids. We have, therefore, repeated the investigation of the dehydrogenation of solanidine obtained from potato sprouts.

The volatile material which distilled when a mixture of 2.1 gm of solanidine and 6 gm of selenium was heated at 340° for 2 hours was separated into basic and neutral fractions. The former was fractionated in a microfractionating column 5 cm in length (Table 1).[5]

TABLE 1

Fraction	Bath temp.	Pressure mm	Wt. in mg of fraction	Micro b.p.	Analysis C	Analysis H
1	92°	30	30	171°	79.15	8.79
2	92°	30	40	173°	79.32	9.21
3	95°	30	40	176°	79.00	9.09
4	120°	13	30	186°	79.70	9.40

The micro boiling point of 2-ethyl-5-methylpyridine[6] is 171°. (Analysis: $C_8H_{11}N$. Calculated. C 79.27, H 9.15.)

A picrate prepared from fraction 1 melted at 142–144° (micro m. p.) and proved indistinguishable from the picrate obtained from the cevine degradation product. A mixed melting point showed no depression. (Analysis: $C_8H_{11}N \cdot C_6H_3O_7N_3$. Calculated. C 47.98, H 4.03. Found. C 48.21, H 3.91.)

The investigation of the much less volatile hydrocarbon dehydrogenation fraction is now in progress and will be reported at a later time. However, the isolation of ethylmethylpyridine in such good yield from solanidine, taken together with the fact that the veratrine alkamines, like the solanum aglycones, can be C_{27} compounds, makes apparent at once the close correlation of the two groups of alkaloids and, therefore, of the veratrine alkaloids with the sterols.

It may be pointed out in this connection that the recent interest[7] which has attached to the study of the cardiac action of veratrine recalls to mind that the digitalis compounds are not only unsaturated lactones but also sterol derivatives. This raises the question whether the cardiac action of both the cardiac glycosides and veratrine is not a property inherent in the sterol nucleus itself, once given the proper supporting groups in certain positions and the necessary stereochemical configurations.

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[1] From the laboratories of the Rockefeller Institute for Medical Research, New York.

[2] L. C. Craig and W. A. Jacobs, *Jour. Biol. Chem.*, 141: 253, 1941.

[3] A. Soltys and K. Wallenfels, *Berichte d. deutsch. Chem. Ges.*, 69: 811, 1936.

[4] H. Rochelmeyer, *Arch. d. Pharm.*, 274: 543, 1936; 275: 336, 1937.

[5] The microanalyses were made by Mr. D. Rigakos of this laboratory.

[6] W. A. Jacobs and L. C. Craig, *Jour. Biol. Chem.*, 124: 659, 1938; 129: 79, 1939.

[7] O. Krayer and R. Mendez, *Jour. Pharm. Exp. Ther.*, 74: 350, 1942.

THE SUCCESSFUL PRODUCTION OF A MAMMALIAN TUMOR WITH A VIRUS-LIKE PRINCIPLE

A METHOD has been developed whereby a powerful tumor-producing principle can be obtained from tumor tissue. Concentrations of a virus-like Berkefeld-passing factor have been produced which when injected subdermally in mice gave rise to tumors, the inception and growth of which were more rapid than that of implants of the donor cancer tissue.

The original tumor material consisted of mammary carcinoma tissue which had passed through more than 30 generations of transplants in dba mice where it initially appeared spontaneously. The tumors induced by the filterable factor were transplantable, rapid-growing and histologically were made up of malignant cells of carcinoma and sarcoma types.

Tumor development took place at the site of the injected material. Additional smaller growths have been found in the liver and in the visceral peritoneum of the digestive tract. There was, as would be expected, considerable variation in the rate of growth of the tumor in individual mice.

This investigation was begun about a year ago, at which time large numbers of eggs were being used in a study concerned with the effects of hypervitaminosis of some of the B vitamins on the growth and development of the chick embryo.[1] It occurred to the author that the yolk sac of the chick embryo might prove of value in demonstrating the possible existence of a virus-like principle as the immediate cause of tumors in general with particular reference to mammalian neoplasm. The successful growth of so many viruses in this medium was, of course, the basis for the idea.

In the meantime some thousands of eggs and more than 300 mice have been utilized on this problem.

Very early in the study, it was found that cell-free filtrates of yolk from chick embryo yolk sacs which had received an injection of tumor tissue a few days previously, contained a substance capable of inducing varying degrees of tissue hyperplasia when injected into a mouse. These growths developed rapidly, but after attaining 1.0 to 1.5 cm in diameter became stationary and then gradually regressed.

Similar growth stimulants could be obtained by injecting ground tumor cells and cell-free extracts of fresh tumor tissue into yolk sacs of chick embryos. It was found that yolk from eggs so treated could be passed by injection from yolk sac to yolk sac for many generations of chick embryos and still the yolk contained tissue growth stimulating substances.

Some months ago it was discovered that tumor tissue grows readily in the yolk sac of the chick embryo.[2] As more attention was given to this method of producing tumor tissue, it was noted that relatively large cancers, several grams in weight, occasionally occurred. Berkefeld filtrates of the yolk surrounding these large tumors contained the virus-like tumor-producing principle to a high degree. The evidence indicates that the tumor cells constantly gave off the virus substance which was caught and preserved by the surrounding yolk. Whether the tumor factor is able to grow independently in the yolk medium has not been definitely determined.

Briefly summarized, the method which proved successful is as follows: The yolk sacs of chick embryos were implanted, as previously described,[2] on the fifth day of incubation with saline suspensions of fresh tumor tissue. The eggs were then incubated for another 12 days, after which the yolk sacs were examined and yolk was collected from those bearing comparatively large tumors (a gram or more). Since the yolk at this time is very thick and viscous, saline solution was added in the portions of 1 to 1. The material was then centrifuged and the supernatant liquid passed through an N-size Berkefeld filter. Care was taken to keep all these operations aseptic. Dba mice were given subdermal injections ($\frac{1}{3}$ cc per mouse) of the filtrate so obtained.

The implications of the successful production of a mammalian tumor with a virus-like cell free product of tumor tissue will be obvious to workers in the cancer field. Certainly the hypothesis held by so many for so long that a virus-like principle is the primary cause of tumorous growths receives support.

There are grounds for hoping that the yolk sac method will prove useful in demonstrating the presence of a virus-like principle in other mammalian tumors and also in the many fowl tumors which have to date proved refractory in this respect. By utilizing eggs of fowls which have relatively long hatching period, it is hoped that this method of attack may be applied to human neoplasms.

A detailed report of methods and results will be given at an early date.

My sincere thanks and appreciation are due Dr. Roger J. Williams for the cooperation he has given me and for the interest and encouragement I have received from him throughout this research. My thanks are also due to my technical assistants, Juanita Thacker, Dorothy Pennington and Marguerite McAfee for their invaluable aid.

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[1] A. Taylor, H. K. Mitchell and M. A. Pollack, Univ. of Texas Pub. 4137, 67, 1941.

[2] A. Taylor, J. Thacker, D. Pennington, SCIENCE, 96: 342, 1942.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

IMPROVED MAGNETIC FLOW SWITCH FOR USE WITH WATER-COOLED X-RAY TUBES

IN the flow switch previously described by me[1] the fit between the piston and the cylinder has a very small tolerance. If the clearance is too great, water may leak through from the intake port to the outlet port without lifting the piston; whereas if it is too small, mud, sand or other foreign matter may lodge in the upper part of the cylinder, fouling the piston so that it fails to drop when the flow of water ceases.

To overcome this difficulty the flow switch has been redesigned. In the new design the fit between piston and cylinder has a large tolerance and the water passing around the piston and through the cylinder constantly flushes the space between them, preventing the lodgment of foreign matter.

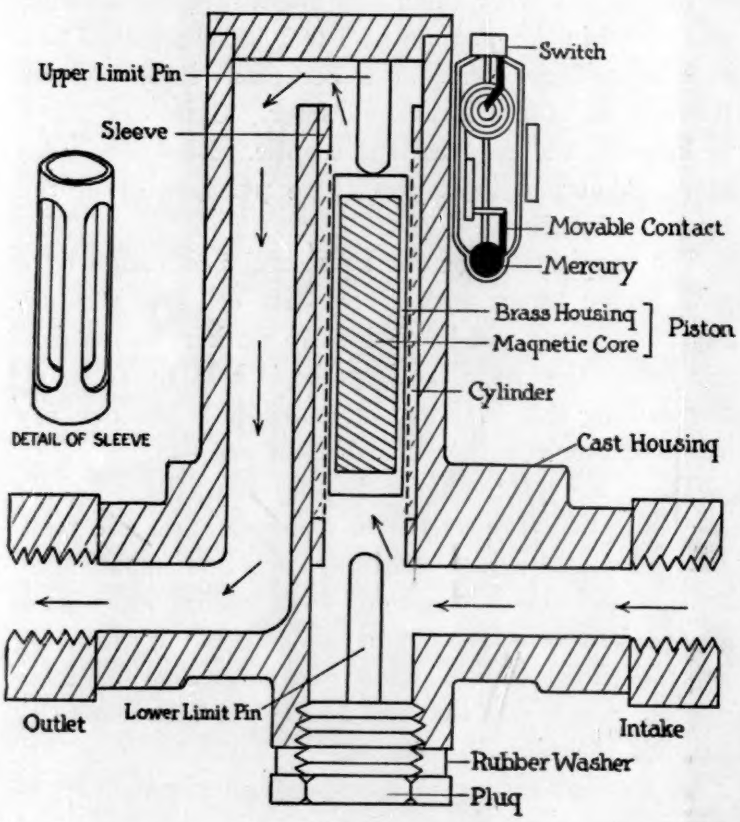

FIG. 1.

Fig. 1 shows the changes in the piston-cylinder assembly. The electrical and magnetic features are unchanged.

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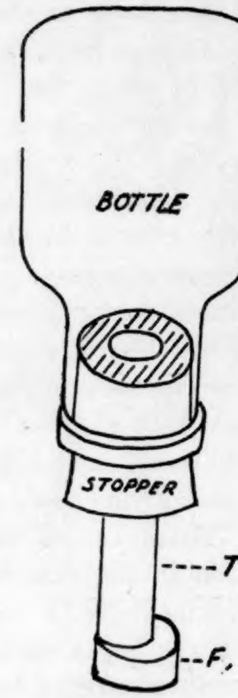
A LARGE FEEDER FOR SMALL CAGES IN AVIAN MALARIA STUDIES

THIS feeder (see sketch) allows access to a relatively large supply of clean seeds, enough to last one canary several days or weeks, depending on the size of the seed container.

[1] Paul C. Hodges, SCIENCE, 94: 424, October 31, 1941.

Particular considerations are that the diameter of tube "T" be wide enough and with its lower end high enough from the bottom of the feed cup to allow for easy passage of seeds; and that the feed cup "F"



allows sufficient space between its wall and that of the tube so the bird can readily but with restriction pick out the seeds.

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BOOKS RECEIVED

A Collection of Articles and Essays on the Great Russian Poet A. S. Pushkin. Illustrated. Pp. 187. Mezhdunarodnaja Kniga.

ADELMANN, HOWARD B. *The Embryological Treatises of Hieronymus Fabricius of Aquapendente.* Illustrated. Pp. xxiii + 883. Cornell University Press. $12.00.

CHRISTENSEN, CLYDE M. *Common Edible Mushrooms.* Pp. x + 124. University of Minnesota Press. $2.50.

HAGAN, WILLIAM ARTHUR. *The Infectious Diseases of Domestic Animals.* Illustrated. Pp. xxvii + 665. Comstock Publishing Company. $6.00.

MERRIAM, JOHN C. *The Garment of God.* Pp. xii + 162. Charles Scribner's Sons. $2.00.

RAPAPORT, DAVID. *Emotions and Memory.* Pp. ix + 282. Williams and Wilkins. $3.00.

STRONG, RICHARD P. *Stitt's Diagnosis, Prevention and Treatment of Tropical Diseases.* Sixth Edition. Two Volumes. Illustrated. Pp. 1826. The Blakiston Company. $21.00.

TAYLOR, LLOYD W., WILLIAM W. WATSON and CARL E. HOWE. *General Physics for the Laboratory.* Revised edition. Illustrated. Pp. vii + 107. Ginn and Company. $2.00.

WALTZ, GEORGE H. *Jules Verne, The Biography of an Imagination.* Pp. 223. Henry Holt and Company. $2.50.

WRANGHAM, D. A. *The Theory and Practice of Heat Engines.* Illustrated. Pp. xii + 756. Macmillan. $10.50.